Claims

What is claimed is:

1. A plasma ashing process for selectively removing photoresist from a semiconductor substrate including a low k material, the process comprising:

forming reactive species by exposing a plasma gas composition to an energy source to form a plasma, wherein the plasma is free from reactive nitrogen species and reactive oxygen species;

exposing the substrate having the photoresist thereon to the reactive species to selectively remove the photoresist and leave the low k material substantially the same as before exposing the substrate to the reactive species.

2. The plasma ashing process according to Claim 1, wherein the process occurs subsequent to an etching process.

3. The plasma ashing process according to Claim 1, wherein the process occurs during a rework process.

4. The plasma ashing process according to Claim 1, wherein the gas composition consists essentially of hydrogen-bearing gas and a noble gas.

5. The plasma ashing process according to Claim 4, wherein the noble gas is helium.

6. The plasma ashing process according to Claim 4, wherein the hydrogen-bearing gas is selected from the group consisting of hydrocarbons, hydrofluorocarbons, and hydrogen gas.

7. The plasma ashing process according to Claim 4, wherein the gas composition further comprises a fluorine-bearing gas.

8. The plasma ashing process according to Claim 7, wherein the fluorine bearing gas is selected from the group consisting of a compound having a formula $C_xH_yF_z$, wherein x ranges from 1 to 4, y ranges from 0 to 9 and z ranges from 1 to 10, HF, F_2 and SF_6.

9. The plasma ashing process according to Claim 1, wherein the substrate comprises a carbon and/ or hydrogen containing insulating layer having a dielectric constant less than 3.0.

10. The plasma ashing process according to Claim 4, wherein the hydrogen bearing gas is hydrogen gas.

11. The plasma ashing process according to Claim 4, wherein the hydrogen bearing gas is in an amount ranging from about 3 percent to about 30 percent by volume of the total plasma gas composition.

12. The plasma ashing process according to Claim 9, wherein the dielectric constant of the carbon and/or hydrogen containing insulating layer essentially does not change during the plasma ashing process.

13. The plasma ashing process according to Claim 1, wherein the chemical composition of the substrate essentially does not change during the plasma ashing process.

14. The plasma ashing process according to Claim 1, further comprising rinsing the substrate, wherein a critical dimension of a feature in the substrate essentially does not change during rinsing.

15. The plasma ashing process according to Claim 14, wherein the rinsing comprises wetting the substrate with an aqueous HF solution.

16. The plasma ashing process according to Claim 1, wherein the reactive species consists essentially of atomic hydrogen.

17. The plasma ashing process according to Claim 1, wherein the reactive species are selected from the group consisting of atomic hydrogen, atomic fluorine and mixtures thereof.

18. The plasma ashing process according to Claim 1, wherein the substrate further comprises a copper metal layer.

19. A post etch plasma ashing process for selectively removing photoresist, polymers and residues from a semiconductor substrate, wherein the substrate includes a layer comprising a carbon and/or hydrogen containing low k dielectric material having a dielectric constant less than 3.0, the plasma ashing process comprising:

placing the substrate including photoresist, and/or polymers and residues on the surface of the substrate into a reaction chamber;

forming reactive species by generating a plasma from a gas composition in the absence of oxygen and nitrogen,

exposing the substrate to reactive species consisting essentially of atomic hydrogen and atomic fluorine; and

selectively removing the photoresist, polymer and residues from the surface by forming volatile compounds, rinse removable compounds and mixtures thereof, wherein the surface of the substrate remains substantially unchanged during the plasma ashing process.

20. The post etch plasma ashing process according to Claim 19, wherein the gas composition consists of hydrogen gas, helium gas and fluorine bearing gas.

21. The post etch plasma ashing process according to Claim 20, wherein the fluorine bearing gas comprises a tetrafluoromethane gas.

22. The post etch plasma ashing process according to Claim 19, wherein the gas composition consists of hydrogen fluoride gas.

23. The post etch plasma ashing process according to Claim 19, wherein the hydrogen gas is in an amount ranging from about 1 percent to about 99 percent of the total gas composition.

24. The post etch plasma ashing process according to Claim 19, wherein the hydrogen gas is in an amount ranging from about 3 percent to about 30 percent of the total gas composition.

25. The post etch plasma ashing process according to Claim 19, wherein the hydrogen gas is in an amount ranging from about 1 percent to about 5 percent of the total gas composition.

26. The post etch plasma ashing process according to Claim 19, wherein an ashing selectivity between the photoresist and the substrate is greater than 50 : 1.

27. The post etch plasma ashing process according to Claim 19, wherein the dielectric constant of the carbon and/or hydrogen containing insulating layer essentially does not change during the plasma ashing process.

28. The post etch plasma ashing process according to Claim 19, wherein the chemical composition of the low k dielectric material essentially does not change during the plasma ashing process.

29. The post etch plasma ashing process according to Claim 19, further comprising rinsing the substrate, wherein a critical dimension of a feature on the substrate essentially does not change during rinsing.

30. The post etch plasma ashing process according to Claim 29, wherein the rinsing step comprises wetting the substrate with an aqueous HF solution.

31. A method of manufacturing a microelectronic device, the method comprising:

forming a photoresist mask on a surface of a semiconductor substrate, wherein the substrate includes a carbon or a hydrogen containing low k dielectric layer;

etching and removing portions of the substrate through openings in the photoresist mask to permanently transfer an image into the substrate and expose a surface of the low k dielectric layer; and

ashing the photoresist mask, polymers and residues from the substrate with a plasma generated from a gas mixture consisting of hydrogen, helium and tetrafluoromethane to selectively remove the mask and residues from the substrate.

32. The method according to claim 31, wherein the low k dielectric layer has a dielectric constant less than 3.0.

33. The method according to claim 31 wherein the carbon-containing low k dielectric layer comprises a polymer having a backbone containing carbon.

34 The method according to claim 31 wherein the carbon-containing dielectric layer comprises a carbon doped oxide.

35 The method according to claim 31wherein the plasma contains from about 1 percent to about 99 volume percent of hydrogen in the gas mixture.

36 The method according to claim 31 wherein the plasma contains from about 10 percent to about 30 volume percent of hydrogen in the gas mixture.

37 The method according to claim 31, wherein the plasma contains from about 1 percent to about 5 volume percent of hydrogen in the gas mixture.

38 The method according to claim 31 further comprising removing the photoresist mask with the plasma at a temperature less than about 450°C and a pressure less than about 6 torr.

39. The plasma ashing process according to Claim 31, further comprising rinsing the substrate subsequent to ashing the photoresist from the substrate, wherein a critical dimension of the image in the substrate essentially does not change during rinsing.

40. The plasma ashing process according to Claim 39, wherein the rinsing step comprises wetting the substrate with an aqueous HF solution.

41. The plasma ashing process according to Claim 31, wherein the ashing step consists essentially of exposing the substrate to atomic hydrogen, atomic helium and atomic fluorine species.

42. The plasma ashing process according to Claim 31, wherein the ashing step consists essentially of exposing the substrate to atomic hydrogen, and atomic helium species.

43. The plasma ashing process according to Claim 31, wherein the etch residues comprise sidewall polymers formed during the etching step.

44. A plasma ashing process for selectively stripping photoresist and/or polymers and residues from a surface of a substrate, the method comprising:

placing a substrate having a photoresist mask thereon into a reaction chamber;

generating a plasma from a gas mixture consisting of hydrogen, helium and tetrafluoromethane, wherein the plasma contains both electrically neutral and charged particles;

substantially removing the charged particles from the plasma;

exposing the substrate and photoresist mask to the electrically neutral species in the plasma, wherein the substrate exposed to the plasma includes a carbon and/or hydrogen containing low k dielectric material; and

ashing the photoresist mask to selectively remove the mask from the substrate, wherein the chemical composition of the low k dielectric layer is substantially the same as before the step of exposing the substrate to the plasma.

45. A plasma ashing process for selectively stripping photoresist and/or polymers and residues from a surface of a substrate, the method comprising:

placing a substrate having a photoresist mask thereon into a reaction chamber;

generating a plasma from a gas mixture consisting of hydrogen and helium, wherein the plasma contains both electrically neutral and charged particles;

substantially removing the charged particles from the plasma;

exposing the substrate and photoresist mask to the electrically neutral species in the plasma, wherein the substrate exposed to the plasma includes a carbon and/or hydrogen containing low k dielectric material; and

ashing the photoresist mask to selectively remove the mask from the substrate, wherein the chemical composition of the low k dielectric layer is substantially the same as before the step of exposing the substrate to the plasma.